Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

FACULTY OF ENGINEERING, MATHEMATICS & SCIENCE

SCHOOL OF ENGINEERING

Electronic & Electrical Engineering

Engineering **Hilary Term, 2018**

Senior Sophister

Annual Examinations

4C4 NEXT GENERATION NETWORKS

5th January 2018 **GOLDSMITH HALL** **09.30 – 11.30**

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Instructions to Candidates:

- **Answer FOUR questions from Part A, and EIGHT questions from Part B.**

Materials Permitted for this Examination:

- **Calculator**
- **Mathematical Tables**

PART A

Q.1

a) Discuss the motivation behind the introduction of wireless local area networks (WLAN), and some examples of application environment.

[6 marks]

b) Describe the infrastructure-based and ad-hoc based modes of WLAN, and some examples of application environment.

[6 marks]

c) Describe the main characteristics, advantages and disadvantages of the IEEE 802.11a system.

[6 marks]

Q.2

Describe the following wireless channel mitigation techniques:

a) Diversity.

[6 marks]

b) Directional antennas.

[6 marks]

c) Coding and modulation.

[6 marks]

Q.3

a) Describe the Critical IoT systems and the related challenges for 5G.

[9 marks]

b) Describe the main characteristics of the LoRa system.

[9 marks]

Q.4

a) Define the concept of Quality of Service (QoS), why it is used, and what some of its related challenges are.

[9 marks]

b) Briefly describe the functionality of some of the tools that can be combined to implement QoS policies in routers.

[9 marks]

Q.5

a) Define the economic and technical challenges that wireless network densification creates for point-to-point optical backhauling.

[6 marks]

b) Describe the process that led to the Cloud-RAN concept, the advantages that it brings, and the constraints that it comes with.

[6 marks]

c) Detail the challenges that Cloud-RAN poses in terms of PON backhauling, and the solutions that are currently being investigated.

[6 marks]

Q.6

a) Describe the difference between the first and second generation of optical networks in the metro-core.

[6 marks]

b) Describe the different ways of making an optical cross connect that you know.

[6 marks]

c) Detail the issues introduced by optical switching in transport networks.

[6 marks]

PART B

For each question you pick, select only ONE answer out of the four available options.

Q.7

Which one of the following statements is incorrect at frequencies above 60 GHz?

a) Propagation characteristics are poor
b) Size of antennas gets smaller
c) Interference with TV systems is an issue
d) RF hardware design is challenging

[3.5 marks]

Q.8

Given an OFDM transmission link in an environment which shows a channel gain which is independent of frequency, which of the following feedback schemes is the most efficient choice to provide channel state information to the transmitter?

a) The feedback channel only depends on the behaviour of the channel over time, so not enough information is provided to answer the question.
b) The channel quality is reported for every subcarrier.
c) The channel quality is reported for sub-channels of N_s subcarriers, where N_s is greater than one and smaller than the maximum allowed number of subcarriers.
d) The channel quality is reported only once.

[3.5 marks]

Q.9

Which of the following statements is incorrect?

a) Conventional radio design encompasses both baseband and RF design.

b) Software radio adds provisions for easy upgrades to conventional radio.

c) Cognitive radio is like software radio, but do not necessarily provides easy upgrades to conventional radio.

d) Cognitive radio techniques impact RF design.

[3.5 marks]

Q.10

With regards to a cellular automata, which of the following statements is incorrect?

a) A cellular automata represents necessarily a physical space.

b) The state at time t+1 depends on the state at time t plus some of the neighbours.

c) The updates follow rules that are typically uniform for all cells.

d) A cellular automata is useful to examine situations with some inherent structure.

[3.5 marks]

Q.11

Which of the following aspects is not among the benefits of license-exempt bands:

a) Facilitating market entry.

b) Providing guaranteed Quality of Service.

c) Providing certainty about spectrum access.

d) Reducing congestion in licensed bands.

[3.5 marks]

Q.12

Which of the following statements about 5G capabilities is incorrect?

a) It will mainly rely on contention-based access.

b) It will deliver a meaningful and efficient broadcast service.

c) It will make the realization of the tactile internet possible.

d) It will make use of massive antenna arrays at the base stations.

[3.5 marks]

Q.13

The requirements for massive machine type communications (mMTC) include:

a) Architecturally sophisticated devices that use a high-complexity transmission mode.

b) Devices that can run on battery power for very long periods of time.

c) Main focus on short transmission ranges for devices in nearby locations.

d) Scalable networks that can connect a large number of M2M devices, but not a small number of them.

[3.5 marks]

Q.14

How can we cope with the increasing capacity demand of modern networks?

a) Increasing radio link efficiency by more advanced physical layer techniques.

b) Increasing the amount of available radio spectrum.

c) Deploying a higher density of nodes in the wireless infrastructure.

d) All of the above solutions are considered by communication engineers to address the capacity crunch problem.

[3.5 marks]

Q.15

In regular (i.e. non-dispersion-shifted) singlemode fiber, what is the limiting factor when pushing for higher bitrates and longer distances?

a) Modal dispersion

b) Chromatic dispersion

c) Polarization dispersion

d) Non-linear effects

[3.5 marks]

Q.16

What determines the wavelength of the light generated by a Fabry-Perot laser?

a) The colour filter on the partially reflective mirror

b) Power: the highest frequency photons generated by stimulated emission will overwhelm the lower frequency photons and dominate the output

c) The resonance frequency of the lasing cavity, as determined by its length

d) Chance: stimulated emission is a probabilistic process that cannot be determined a-priori

[3.5 marks]

Q.17

What is the sensitivity of an optical receiver?

a) The ratio of the intensity of the generated current I_p and the power absorbed P_{in}

b) A measure of the effects of environmental factors such as temperature on the accuracy of the receiver

c) The maximum amount of power the receiver can absorb before it saturates

d) The minimum amount of power needed to obtain a given BER for a given bitrate

[3.5 marks]

Q.18

Why is ranging necessary in TDM or TWDM PONs?

a) To charge customers proportionally to the length of fibre that was necessary to connect them to the network

b) To ensure that the latency experienced by the end-users is within an acceptable range for all customers

c) To avoid collisions in the shared upstream channel

d) To guarantee synchronization in the broadcast downstream channel

[3.5 marks]

Q.19

Which of these technologies cannot be offered by an OLO with Local Loop Unbundling (LLU)?

a) ADSL

b) VDSL2

c) Point-to-point fibre

d) None - these can all be implemented with LLU

[3.5 marks]

Q.20

In Software Defined Networks (SDN), which of the following statements is false?

a) The control plane and the forwarding plane are physically separated

b) The data plane can be programmatically controlled in a centralized fashion

c) Data can be switched on a per-flow basis

d) There is only one instance of the controller regardless of the size of the network

[3.5 marks]

Q.21

What happens in an OpenFlow-enabled switch when a packet is received that does not match any of the known forwarding rules?

a) The packet is discarded

b) The packet is broadcast on all ports; some other switch will know what to do

c) The packet header is forwarded to the controller so that it can instruct the switch on what to do

d) The packet is forwarded by reverting to traditional non-SDN routing protocols

[3.5 marks]

Q.22

Network Function Virtualization (NFV) is:

a) Just a different name for Software Defined Networking

b) The "softwarization" of typical network functions so that they can be run on commodity hardware and/or virtual machines

c) A polymorphism technique that allows operators to customize an abstract networking service by declaring some of its functions as virtual

d) Orthogonal to SDN: you can have one or the other, but not both

[3.5 marks]